United States Patent

Corbaz

[15] **3,648,929**

[45] **Mar. 14, 1972**

[54] ATOMIZER

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[73] Assignee: **Battelle Memorial Institute, Geneva, Switzerland**

[22] Filed: **Feb. 8, 1971**

[21] Appl. No.: **113,385**

[52] **U.S. Cl.** **239/102, 239/272, 239/309, 239/376**

[51] **Int. Cl.** **B05b 3/14**

[58] **Field of Search** 239/102, 4, 272, 309, 375, 239/376, 378, 379, 101

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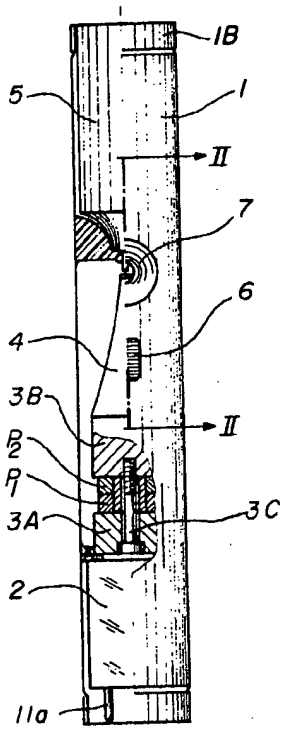
[57] **ABSTRACT**

A portable, handy and autonomous atomizer operating without a propellent gas and comprising an elongated casing in which are coaxially mounted a removable liquid-containing cartridge, an electronic oscillator, a transducer, energized by the periodic signals issuing from the oscillator, for converting these signals into mechanical vibrations having a frequency at least equal to that of the signals, and an amplifier for amplifying these vibrations at one end thereof. In the casing are also provided a supply voltage source and means for feeding the liquid out of the cartridge to a portion of said one end of the amplifier thereby to form an aerosol jet, said portion projecting out of an opening in the casing wall and the discharge end of the cartridge facing said one end.

5 Claims, 3 Drawing Figures



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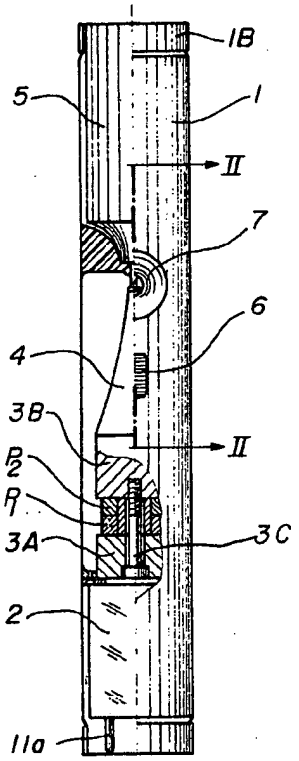


FIG. 1

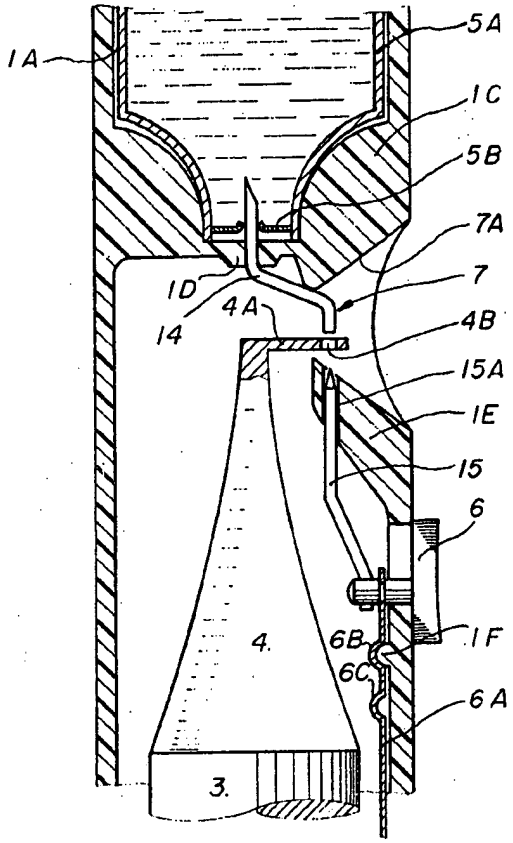
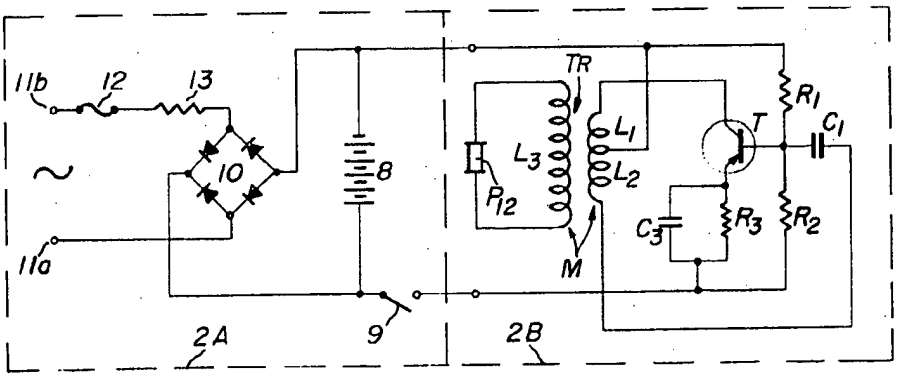


FIG. 2

FIG. 3



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ATOMIZER

DISCLOSURE

This invention relates to atomizers of the kind including an electronic oscillator, a transducer which is energized by the periodic signals issuing from the oscillator and which converts these signals into mechanical vibrations, an amplifier for amplifying the amplitude of these vibrations, a reservoir of liquid to be atomized, and means for feeding this liquid to the amplifier whereby the liquid may be atomized by the amplified vibrations to form one or more aerosol jets.

Atomizers of this kind have already been proposed, in particular for atomizing highly cohesive liquids, such as for instance mineral oils and various paints and coating substances. Use has also been made of such apparatus for medical applications, in particular for administering certain substances orally and nasally or on various parts of the body.

In general, such atomizers consist of static or cumbersome units of a relatively large size that are supplied with electric energy off the mains to which they must therefore necessarily be connected during use.

An object of the invention is to produce a portable atomizer which is of sufficiently small dimensions to form a handy pocket-sized apparatus and which is supplied by an autonomous source of electric energy.

According to the invention there is provided an atomizer, comprising a casing in which are disposed a supply voltage source, an electronic oscillator, a transducer which is energized by the periodic signals issuing from the oscillator and which converts these signals into mechanical vibrations having a frequency corresponding at least to those of said signals, an amplifier for amplifying the amplitude of these vibrations, a reservoir of liquid to be atomized, means for feeding this liquid to the amplifier thereby to atomize the liquid into at least one aerosol jet, wherein the reservoir consists of a removable cartridge, and the cartridge, the amplifier and the transducer occupy, within the casing, a substantially coaxial position, with the discharge opening of the cartridge facing the free end of the amplifier and the wall of the casing being formed with an opening into which projects at least that part of the free end of the amplifier which receives the liquid to be atomized whereby the aerosol jet that is produced may mainly be so produced outside the casing.

In the accompanying diagrammatic drawings:

FIG. 1 illustrates, half in axial section, half in elevation, one embodiment of an atomizer according to the invention;

FIG. 2 is a section along line II—II of FIG. 1, on a larger scale; and

FIG. 3 is an electronic diagram thereof.

The illustrated atomizer comprises a cylindrical casing 1 having for example a diameter of a few centimeters so that it may readily be held by the user. In this casing are disposed a periodic signals electronic generator 2, a transducer 3 which is energized by the electric signals issuing from the generator and which converts these signals into mechanical vibrations having a direction parallel to the longitudinal axis of the transducer an amplifier 4 for amplifying these vibrations, a cartridge 5 filled with liquid to be atomized and which is removably disposed in the casing 1 so that it may be replaced, when required, by another similar cartridge, a pushbutton 6 by means of which the user can operate the atomizer in the manner described hereinafter to produce an aerosol jet through an opening 7 in the casing 1 or to stop such an emission.

The electrical diagram for the generator 2 is visible in FIG. 3: this generator 2 comprises a supply block 2A and a high-frequency oscillator 2B, here an oscillator of ultrasonic frequency.

As will be observed, the supply block comprises a storage cell 8, e.g., a cadmium-nickel storage cell, to which the oscillator 2B can be connected via a switch 9 (FIGS. 2 and 3) actuated by the pushbutton 6. The block 2A comprises moreover a circuit for charging the storage cell 8, formed by a rectifying unit 10, in a Graetz bridge circuit arrangement, which is connected at its output to the terminals of the storage cell and whose input is connected to two pins 11*a* and 11*b*. These two pins project from one end of the casing 1 and can be connected to an AC supply mains via a suitable flex not shown. Between the pin 11*b* and the corresponding input of the rectifying unit 10 are arranged a fuse 12 and a resistor 13, the latter serving to adapt the voltage being applied across the terminals 11*a* and 11*b*.

The oscillator 2B is a Hartley oscillator comprising a transistor T whose emitter is earthed through an R-C group formed by a resistor R_3 and a capacitor C_3 and whose base circuit includes biasing resistors R_1 and R_2, a capacitor C_1 and an inductor L_2 formed to one part of the primary winding of a transformer T_R. The other part of this winding forms an inductor L_1 connected to the collector of transistor T.

The secondary winding of transformer T_R, forming an inductor L_3, is connected to the terminals of piezo-electric elements P_1 and P_2 comprised by the transducer 3 (FIG. 1), these elements forming a capacitor P_{12}.

The reaction in the base circuit of transistor T is obtained by means of the capacitor C_1, of the part of the primary winding of transformer T_R forming the inductor L_2, and of the mutual inductance M of the transformer windings.

The capacitor P_{12} and the inductors of the transformer T_R form a circuit tuned to the frequency of the periodic signals to be produced by the oscillator.

This oscillator can of course also have a circuit different from that shown provided it is able to supply periodic signals at a very high frequency, in particular a supersonic frequency, with a minimum consumption of electric energy.

These electric signals serve to energize the transducer 3 and the purpose of the latter is to convert these signals into mechanical vibrations. The illustrated transducer is designed to vibrate at "half-wave" and comprises, firstly, the two piezo-electric elements P_1 and P_2, formed by a pair of similar annular components, made for instance of lead zirconate-titanate, and having an electrode on each plane face, and, secondly, two similar cylindrically-shaped metal components 3A and 3B between which the elements P_1 and P_2 are clamped by a bolt 3C which extends through the component 3A, through the elements P_1 and P_2, and which is threaded into the component 3B.

The two electrodes of elements P_1 and P_2, that are in contacting relationship are connected to one end of the secondary winding of transformer T_R and the other electrodes of elements P_1 and P_2 are connected to the other end of this secondary winding.

The unit formed by the components 3A and 3B and by the piezo-electric elements P_1 and P_2 has a length equal to $\lambda/2$, λ being equal to a multiple of the wavelength of the periodic signal produced by the oscillator.

The amplifier 4 is formed by an appendage of component 3B, having a length equal to $\lambda/2$ and having a diameter which varies exponentially. If d_1 is the diameter of the larger base of the amplifier and d_2 is the diameter of the smaller base, the coefficient of amplification that can be obtained will be equal to d_1/d_2.

Thus, the mechanical vibrations to which component 3B is subjected are amplified in the above ratio at the level of the free end of the amplifier 4. Consequently, the density of energy at this end is particularly high and any liquid deposited there will be thoroughly atomized.

The amplifier 4 is here provided with a beak 4A extending transversely to its axis of symmetry and projecting slightly out of the casing 1, through the opening 7. It is on this beak 4A that is dispensed the liquid to be atomized as will be seen later.

The cartridge 5 comprises a tubular container 5A, e.g., of synthetic material, transparent or otherwise, having a mouth which is closed off by a diaphragm 5B of preferably resilient synthetic material. This cartridge, which is removable, has an external diameter which is slightly less than that of a chamber 1A formed in the upper part of the casing 1, such chamber

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being normally closed by a fit-on or snap-on lid 1B. A similar lid is provided at the other end of the casing 1 to protect pins 11*a* and 11*b* when not in use.

As shown in FIG. 2, the base 1C of chamber 1A has a profile conjugate with that of the part of cartridge 5 adjacent its mouth, so as to ensure very exact positioning of the cartridge in the casing. From the center of base 1C projects into the chamber 1A the upper end of a tube 14 of which an intermediate part is held in a boss 1D integral with this base. The lower end of the tube is offset radially outwardly and opens opposite a passage 4B formed in the beak 4A substantially in the plane of the opening 7 in casing 1.

The tip of the tube portion which extends into the chamber 1A is sharp so that a cartridge 5 upon being fully inserted into this chamber will cause the diaphragm 5B to be punctured through impalement on the sharp tip of tube 14. Since the diaphragm is made of resilient material, the edges of the puncture thus formed will come to be applied elastically against the outer surface of tube 14 and will do so with a force sufficient to ensure good fluidtightness around the tube.

The internal diameter of tube 14 is preferably sufficiently small for liquid in the cartridge to escape only with difficulty, by gravity or under the action of a slight parasitic acceleration due for instance to a shake to which the described atomizer could be subjected.

By way of additional precaution, the atomizer is here fitted with a closure member for this conduit in the form of a needle 15 disposed coaxially with the passage 4B in beak 4A and with the lower end of tube 14, this needle being slidably mounted in a passage 15A formed in a boss 1E inside casing 1 and being rigid with the previously mentioned pushbutton 6.

The pushbutton 6 can be positioned in two extreme, upper and lower, positions in either of which it is held by a blade 6A rigid therewith. This blade is made of resilient material and is formed with two recesses 6B and 6C capable of being brought into alternate engagement with a projection 1F inside the casing by axial sliding displacement of the blade. The spacing of the recesses 6B and 6C corresponds to the distance between the two extreme positions into which the pushbutton 6 is to be moved.

In the upper position for this pushbutton the needle 15 is engaged in the lower orifice of tube 14 to close the latter and the switch 9, controlled by the blade 6A, is in the open position.

When the pushbutton 6 is moved to its lower position, which is that shown in FIG. 2, the needle 15 is remote from the tube 14 and the switch 9 is closed. The oscillator 2B is thus being supplied with electric current and hence produces a periodic signal of supersonic frequency to energize the transducer, this signal being converted into amplified mechanical vibrations by the amplifier 4, as described.

Further, since the lower orifice of the tube 14 has been cleared, the liquid in the cartridge can be made to flow in this tube and on to the beak i.e., Since the latter is being subjected to vibrations of particularly high frequency and amplitude, the liquid, as it arrives on this beak, or even within the immediate proximity thereof, is atomized, i.e. fractionated into a cloud of particles of particularly small size, each having sufficient kinematic energy to propel itself and to form, in conjunction with the other particles of the cloud, an aerosol jet. In the illustrated atomizer, this jet will have a path of travel transverse to the longitudinal axis of the apparatus and directed slightly upwards. This is due essentially to the shape and direction of the beak 4A and to the fact that atomization essentially takes place on the upper surface of the latter.

The opening 7 is surrounded a conical recess 7A in the side wall of the casing having a regulating action on the resulting jet. This recess acts as it were as a "reflector" for liquid particles having a disordered path of travel and coming to impinge on its surface.

Moreover, although so far reference has only been made to an amplifier having a profile that varies exponentially, clearly the amplifier could, by way of modification, have a different shape, as it is this shape which determines the amplification that is achieved. The transducer could also be designed in a manner different from that envisaged previously.

The illustrated atomizer forms an autonomous unit of particularly small size capable of being carried by its user, e.g. in a pocket or, in the case of women, in a bag.

It is thus particularly well-suited for medical purposes, for orally or even nasally administering all sorts of medicaments, or for periodically applying therapeutic aerosols on wounds of all kinds or on other external parts of the body. In addition, since the liquid is being atomized without resorting to a "propellant," the use of the described apparatus is practically universal: for instance it is possible to form aerosols with liquids that are chemically incompatible with the gases used as propellants.

As the described atomizer operates noiselessly it can be used discreetly in all places and under any circumstances, this being a particularly important advantage as regards its medical applications.

I claim:

1. An atomizer comprising a casing in which are disposed a supply voltage source, an electronic oscillator, a transducer which is energized by the periodic signals issuing from the oscillator and which converts these signals into mechanical vibrations having a frequency corresponding at least to those of said signals, an amplifier for amplifying the amplitude of these vibrations, a reservoir of liquid to be atomized, means for feeding this liquid to the amplifier thereby to atomize the liquid into at least one aerosol jet, wherein the reservoir consists of a removable cartridge and the cartridge, the amplifier and the transducer are substantially coaxially positioned within the casing, with the discharge end of the cartridge facing the free end of the amplifier and the wall of the casing being formed with an opening through which projects at least that part of the free end of the amplifier which receives the liquid to be atomized.

2. An atomizer according to claim 1, wherein the discharge end of the cartridge is closed off by a perforatable diaphragm, the casing has means for leading the cartridge to, and maintaining it in, its position of use, and said liquid-feeding means include a tube having one end opening in the vicinity of said free end of the amplifier and whose other end is sharp and occupies in the casing a position such when the cartridge is being led to said position of use, the cartridge comes to impale itself on this other end of the tube thereby perforating the diaphragm and enabling the cartridge to communicate with the tube.

3. An atomizer according to claim 2, wherein a passage extends through the free end of the amplifier in coaxial alignment with said one end of the tube and with an axially movable needle to the side of the passage opposite the tube and capable of being displaced into two operative positions, the first being the tube closing position, in which it is engaged in the orifice of said one end of the tube, the other being the tube opening position, remote from the latter.

4. An atomizer according to claim 3, wherein a push-member, projecting from the casing, is kinematically solid with the needle and is capable of being moved axially over a given length corresponding to the distance travelled by said needle between its two operative positions, and wherein a switch is provided for controlling the supply of the electronic oscillator by said supply source, said switch being actuated by said push-member so as to interrupt said supply when the needle is moved to its tube-closing position and so as to restore this supply when the needle is moved to its position remote from said tube.

5. A portable, handy and autonomous atomizer operating without a propellent gas and comprising an elongated casing in which are coaxially mounted a removable liquid-containing cartridge, an electronic oscillator, a transducer, energized by the periodic signals issuing from the oscillator, for converting these signals into mechanical vibrations having a frequency at least equal to that of the signals, and an amplifier for amplifying these vibrations at one end thereof the casing being also

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provided with a supply voltage source and means for feeding the liquid out of the cartridge to a portion of said one end of the amplifier thereby to form an aerosol jet, said portion projecting out of an opening in the casing wall and the discharge end of the cartridge facing said one end.

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Dedication

3,648,929.—*Andre Corbaz,* Geneva, Switzerland. ATOMIZER. Patent dated Mar. 14, 1972. Dedication filed Mar. 26, 1984, by the assignee, *Battelle Memorial Institute.*

Hereby dedicates to the People of the United States the entire remaining term of said patent.

[*Official Gazette July 3, 1984.*]